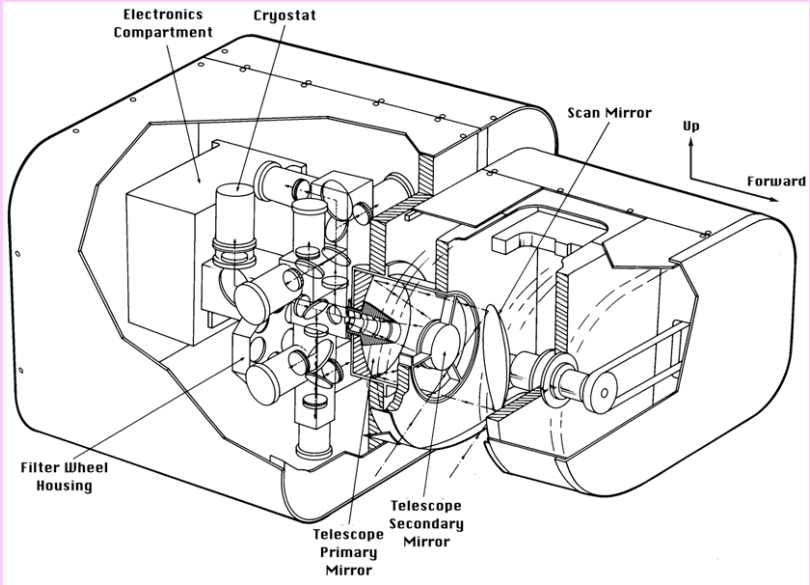
CLOUD ABSORPTION RADIOMETER (CAR)



http://car.gsfc.nasa.gov

PRINCIPAL INVESTIGATOR

DR. MICHAEL D. KING
SENIOR SCIENSTIST
EARTH OBSERVING SYSTEM

Cloud Absorption Radiometer: Genesis!

- Goddard Space Flight Center
  - developed in 1982-1983
- University of Washington
  - integrated & flown in 1984 (B-23)
  - principal data from 1987-97 (C-131A)
  - flights after 1998 (CV-580)

University of Washington CV-580

Comparison between CAR and MAS

CAR

- Spectral Bands = 14
- Data rate = 12 KHz
- Data resolution = 16 bits
- Spectral range = 0.34–2.30 µm
- IFOV = 17.5 mrad
- Ground Resolution @ 667 m agl = 10 m
- Total scan angle = 190˚
- Swath width = 180° plane
- Pixels/scan line = 382
- Calibration Method = integrating sphere
- Place = Goddard Space Flight Center

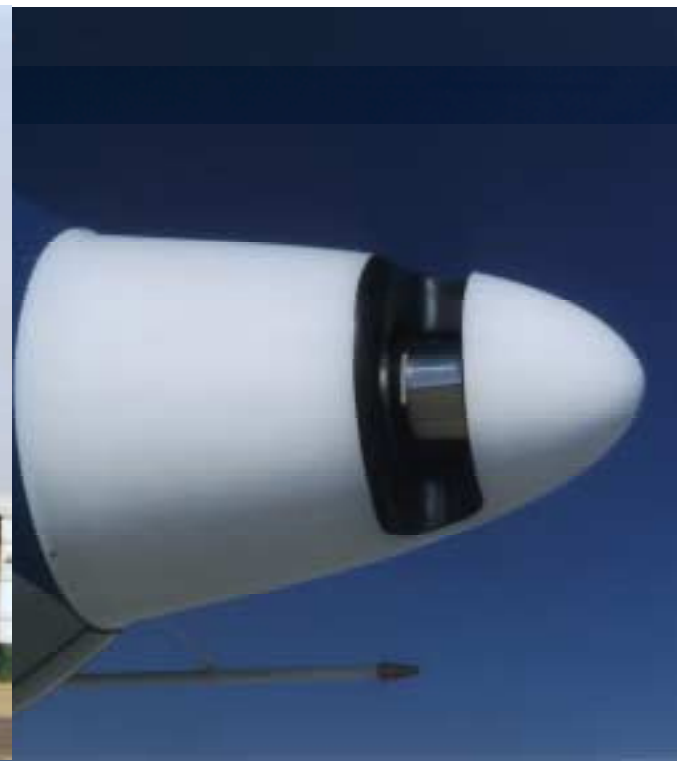
MAS

- Spectral Bands = 50
- Data rate = 19 KHz
- Data resolution = 16 bits
- Spectral range = 0.46–14.24 µm
- IFOV = 2.5 mrad
- Ground Resolution @ 20 km agl = 50 m
- Total scan angle = 85.24˚
- Swath width = 36 km
- Pixels/scan line = 716
- Calibration Method = spectroradiometer
- Place = Ames Research Center

Illustration of CAR Scanning Modes

Horizontal mode

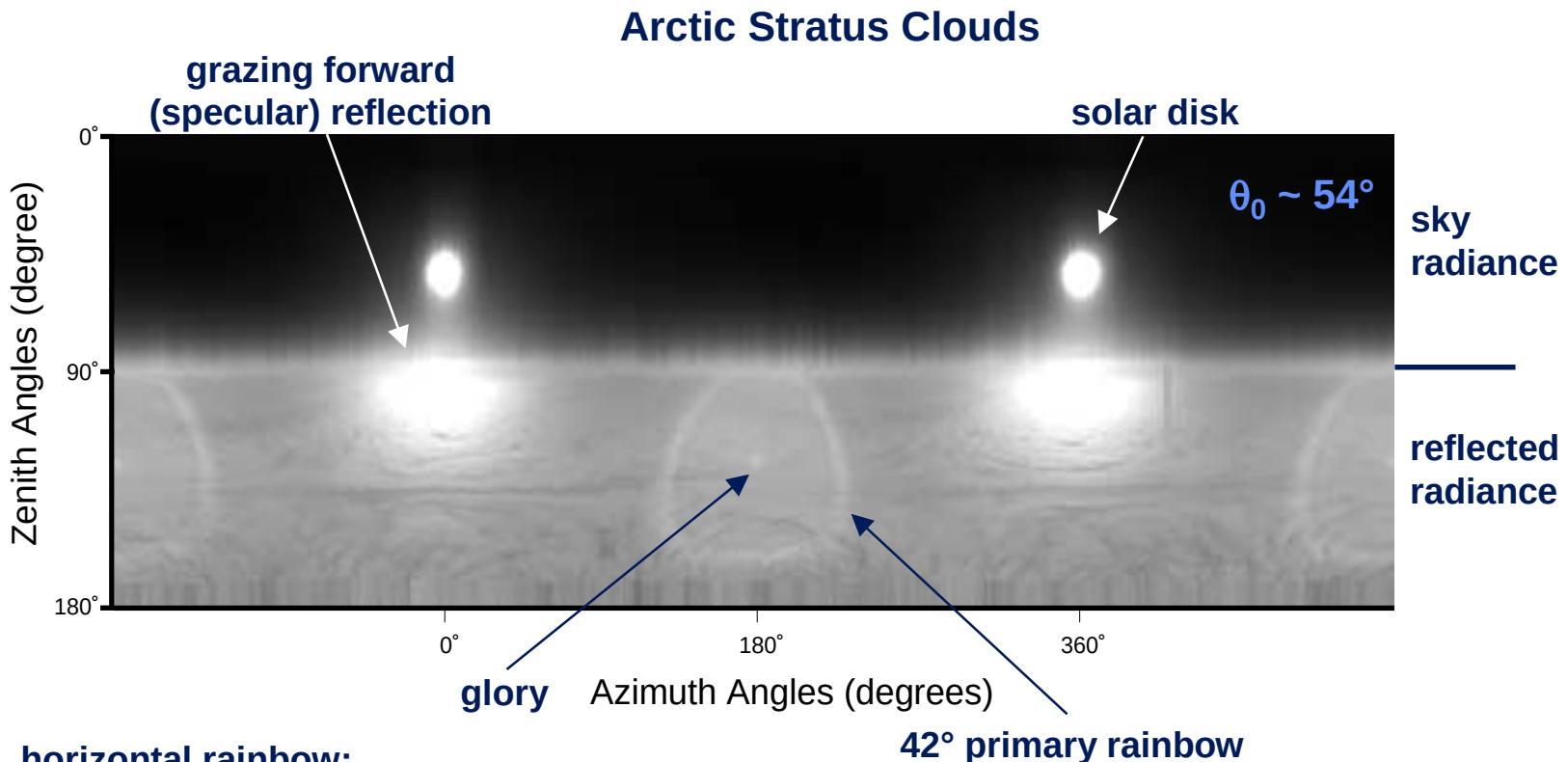
Vertical mode



Example 1: Arctic Stratus Clouds during FIRE ACE

λ = 0.66 µm

May 29, 1998

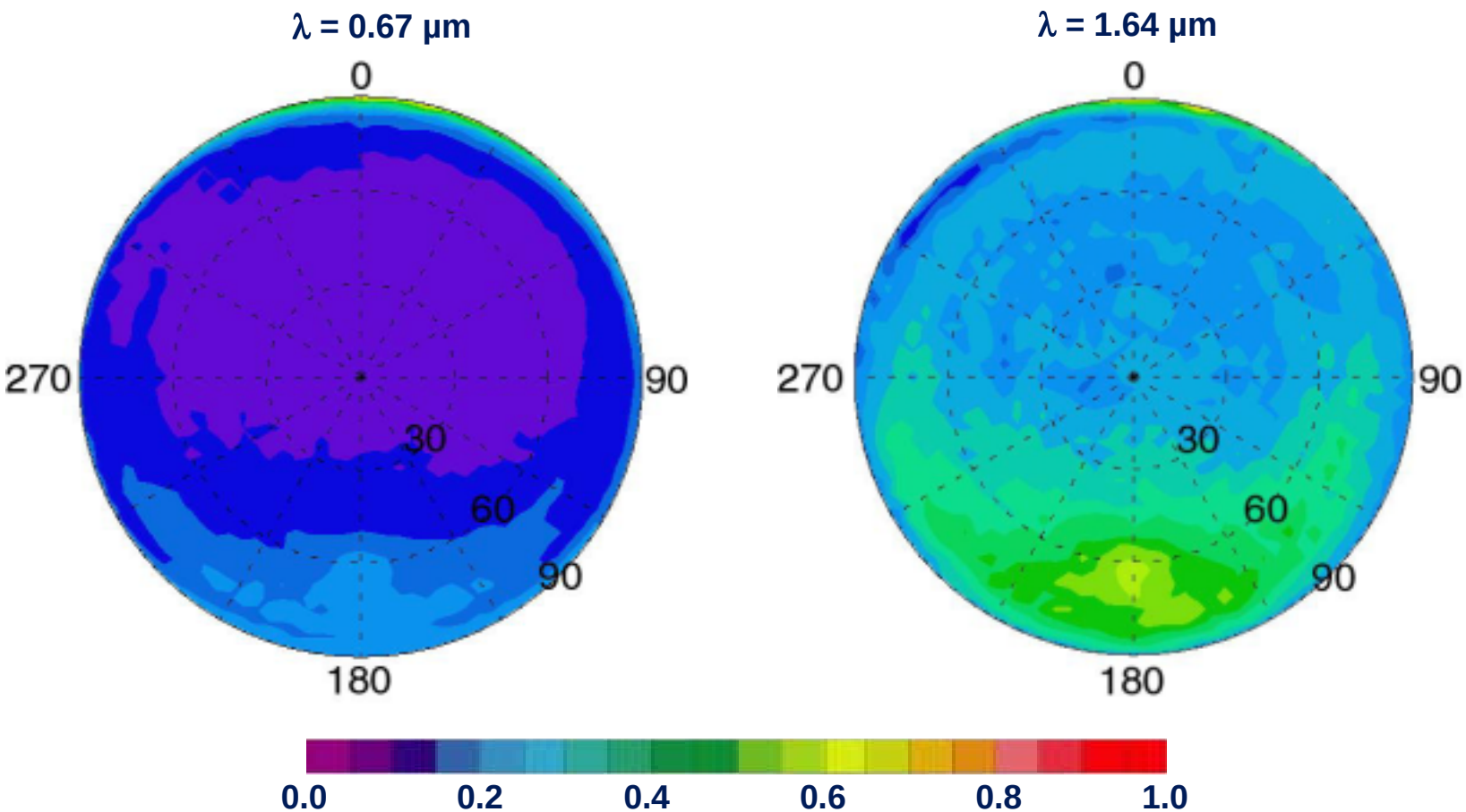


horizontal rainbow:

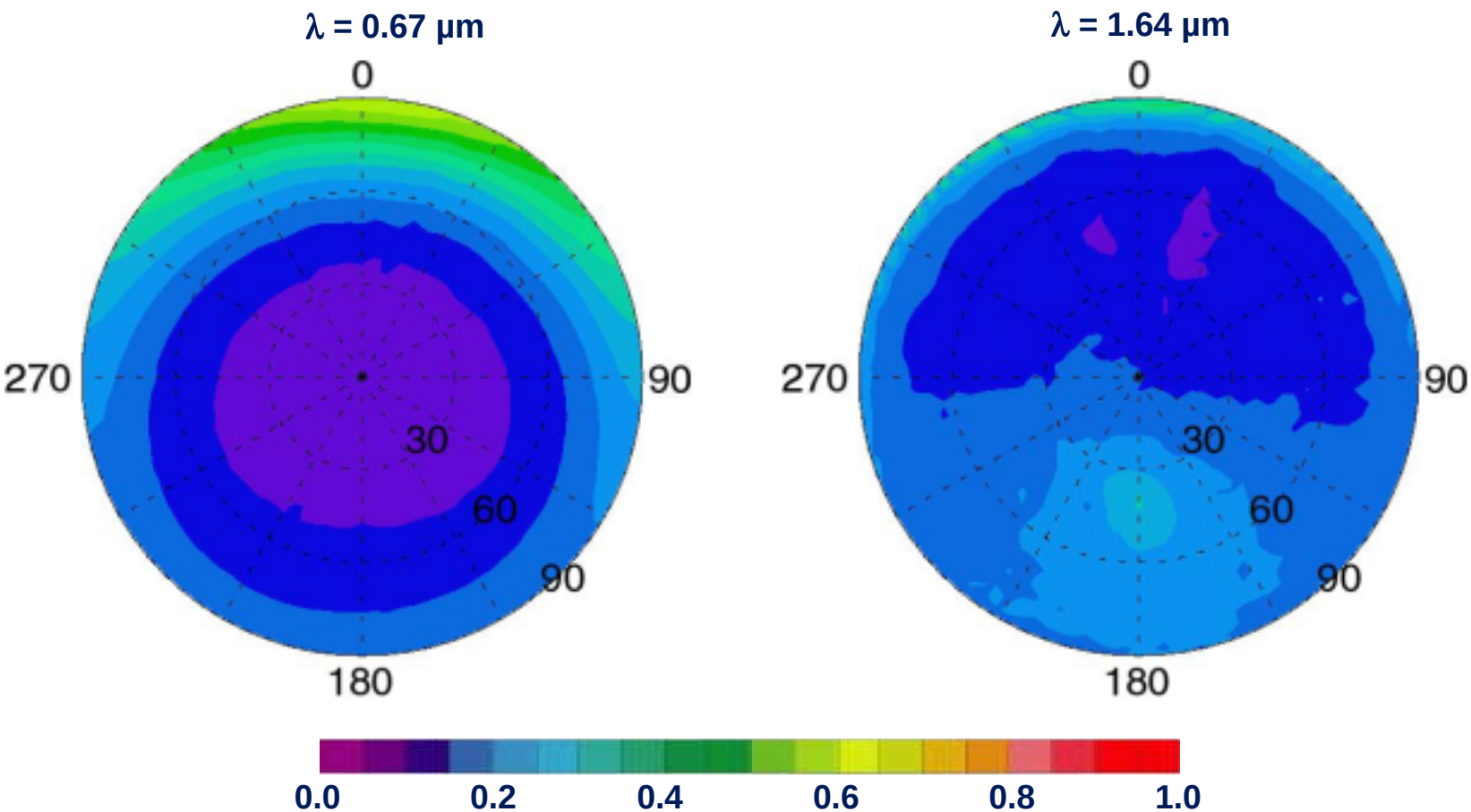
- **sun elevation (90° – θ_0) > 42°, ellipse; < 42°, hyperbola; overhead sun, circle**

Example 2: Bidirectional Reflectance - Cerrado

Brazil (θ_0 = 60°)



Example 3: Bidirectional Reflectance - Smoke Layer Brazil (θ_0 = 38°)



Example 4: Sensitivity of Off-Nadir Zenith Angles to the Surface Reflectance Ratio Technique

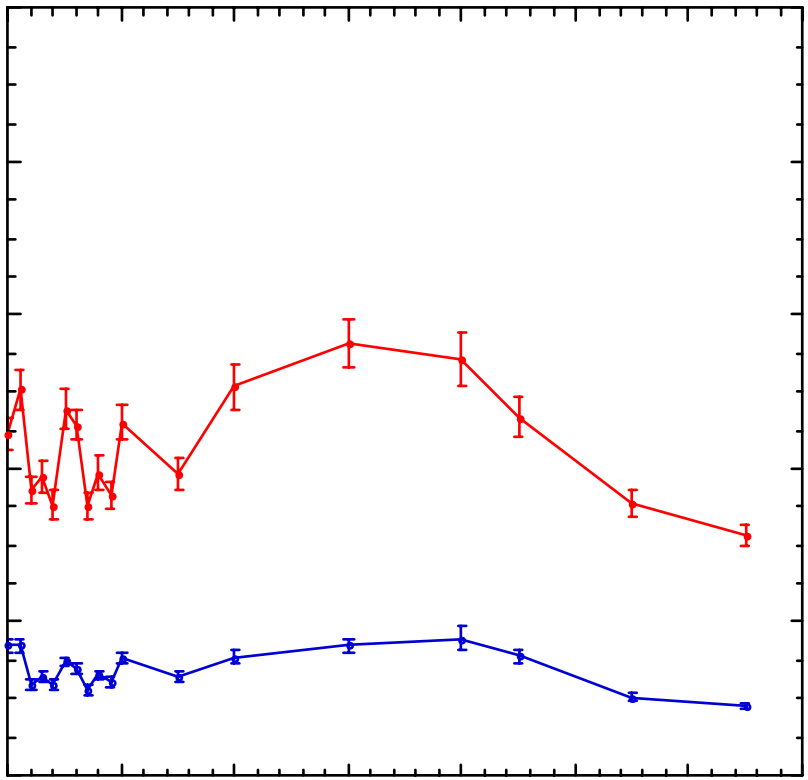
Charles Gatebe,[1,2] Michael D. King,[1] Si-Chee Tsay,[1]
Qiang Ji,[3] Tom Arnold,[4] and Jason Li[4]

[1]NASA Goddard Space Flight Center
[2]University of Maryland Baltimore County
[3]Science Systems and Applications, Inc.
[4]SM&A Corporation

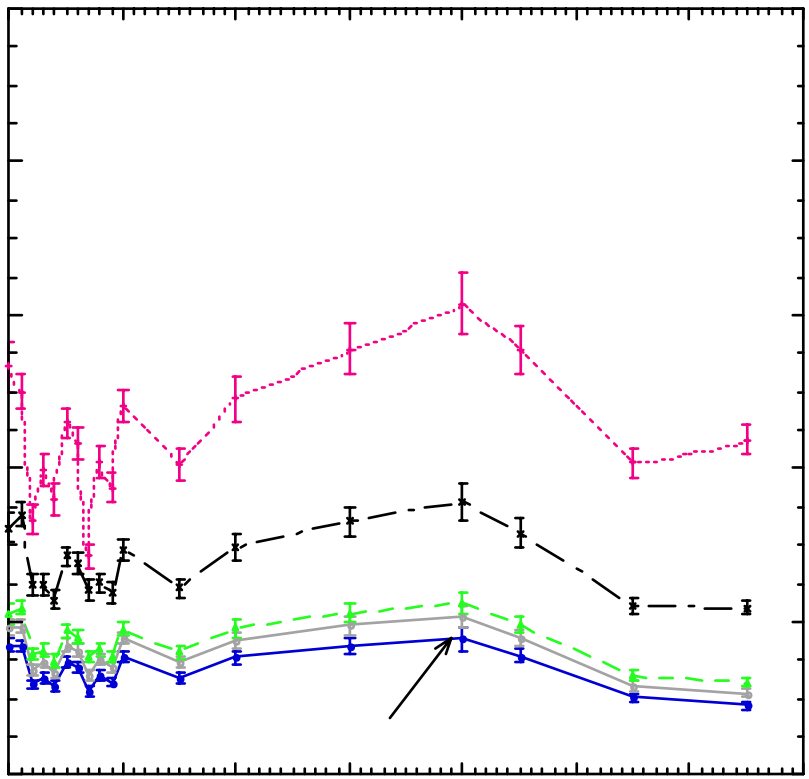
Outline

- ← Spectral variation of surface reflectance over land
  - – Important for the retrieval of aerosol optical thickness over land

Example 4a: Slope of Reflectance $R^{0.670.47(0.67)}/ R^{2.20}$ - Brasilia

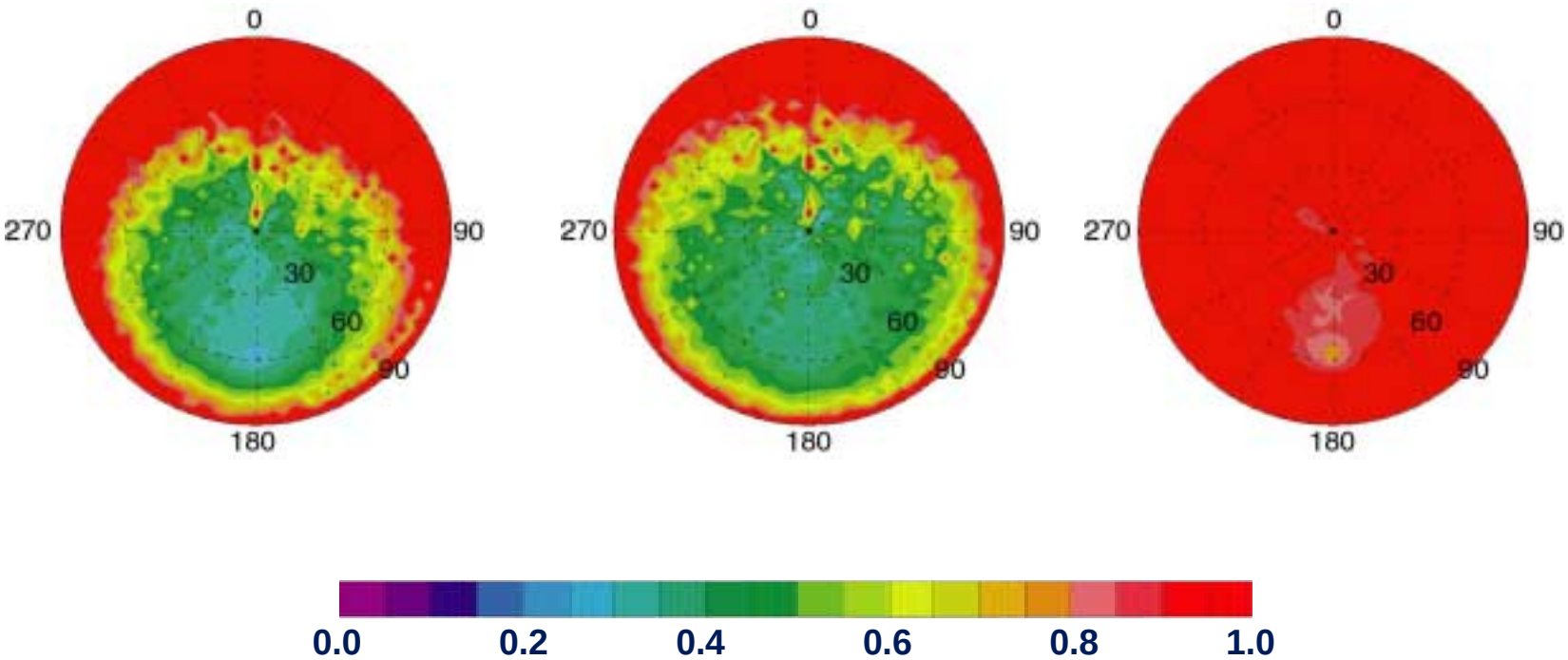


Example 4b: Slope of reflectance $R^{0.47}/R^{2.20}$ for different aerosol optical thickness (τ_a)



Example 4c: Azimuthal variation of $R^{0.47(0.67)}/R^{2.20}$ - Dense Forest

$R^{0.47}/R^{2.20}$ $R^{0.67}/R^{2.20}$ $R^{0.47}/R^{0.67}$

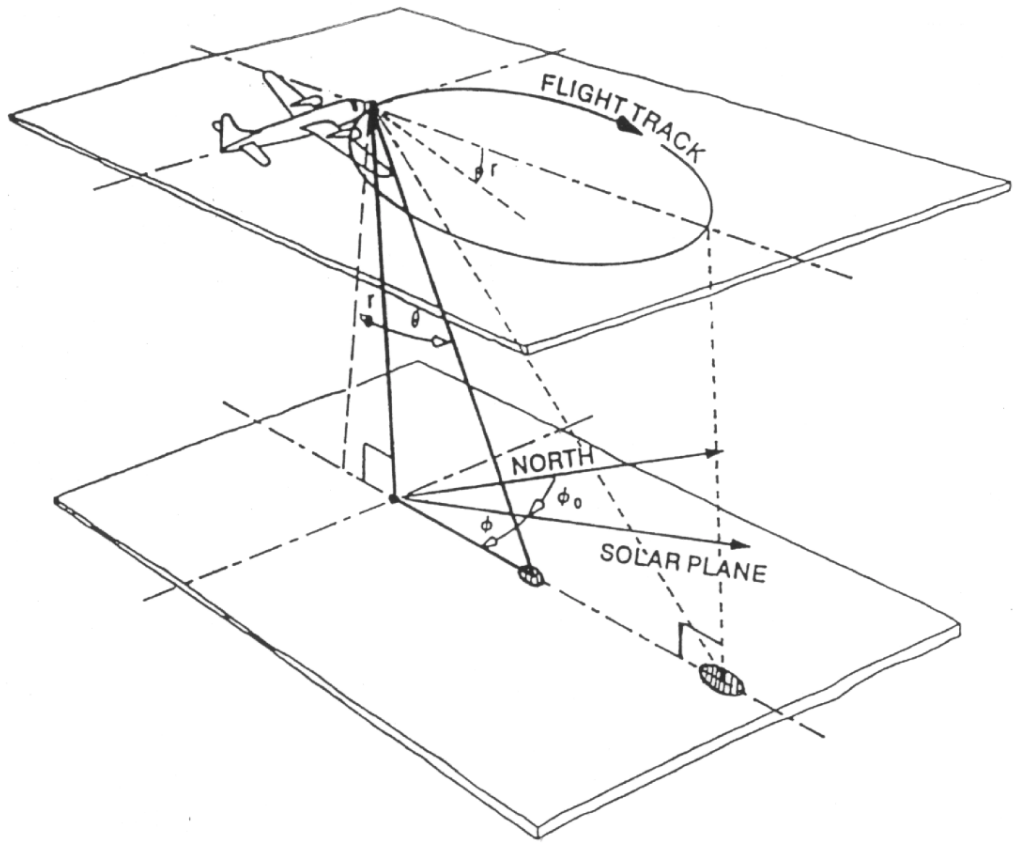


Proposed CAR measurements during CLAMS

- Surface bidirectional reflectance (BRDF) measurements to be acquired for several $f(\theta_0)$ over the Ocean with and without sunglint
  - altitude (100 ft, 2000 ft, and 20 000 ft)
- Surface bidirectional reflectance measurements to be acquired over the Dismal swamp
  - altitude (100 ft, 2000 ft, and 20 000 ft)
- Sky radiance measurements: CAR in the upward imaging mode
  - for several $f(\theta_0)$ at 100 ft
- Sky/surface radiance measurements at constant level: CAR in the vertical imaging mode

Illustration of Bidirectional Reflectance Measurements

- ← Roll: ~20°
- ← Time: ~3 min
- ← Speed: ~80 m s^{-1}
- ← Height: ~667 m
- ← Diameter: ~3 km
- ← Resolution
  - 10 m (nadir)
  - 270 m (θ = 80°)
- ← Channels
  - 8 continuously sampled (0.34-1.27 μm)
  - 2 filter wheel channels used for BRDF measurements (1.64 & 2.20 μm)



Future:
SPECTRAL, ANGULAR, AND VERTICAL CHARACTERIZATION OF AEROSOLS RADIATIVE PROPERTIES

- PI: CHARLES K. GATEBE
  - GEST/UMBC
- CO- PI: O. DUBOVIK
  - SSAI
- COLLOBORATORS
  - M.D. KING
  - S.-C. TSAY
  - P. HOBBS

Planned Activities for the future

- Phase 1: Develop a new algorithm by modifying the AERONET inversion code of Sun/Sky radiance

- Phase 2: Test algorithm using simulated data, field measurements data from Kuwait Oil-fires Experiment, SCAR-B, TARFOX, SAFARI-2000 and CLAMS

- Phase 3: conduct a well focussed experiment here in the USA for the purpose of improving the algorithm. Measurements will be co-located with, SMART, CAR, MODIS, and TOMS.